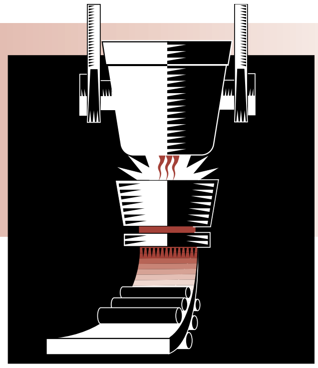
STEEL

Project Fact Sheet



Advanced Control of Operations in the Blast Furnace

Benefits

- Minimize fuel requirements to achieve the blast air requirements of the blast furnace iron production process
- Improved operational consistency of the overall stove system
- Improved stove system reliability through increased conformance to stove system design based operational constraints
- Minimize the severity of hanging conditions in the blast furnace to promote more consistency in heat and mass transfer and reaction kinetics leading to higher efficiency and productivity of the blast furnace
- Improve process control to minimize cold blast furnace conditions and reduce the variability of molten iron temperature

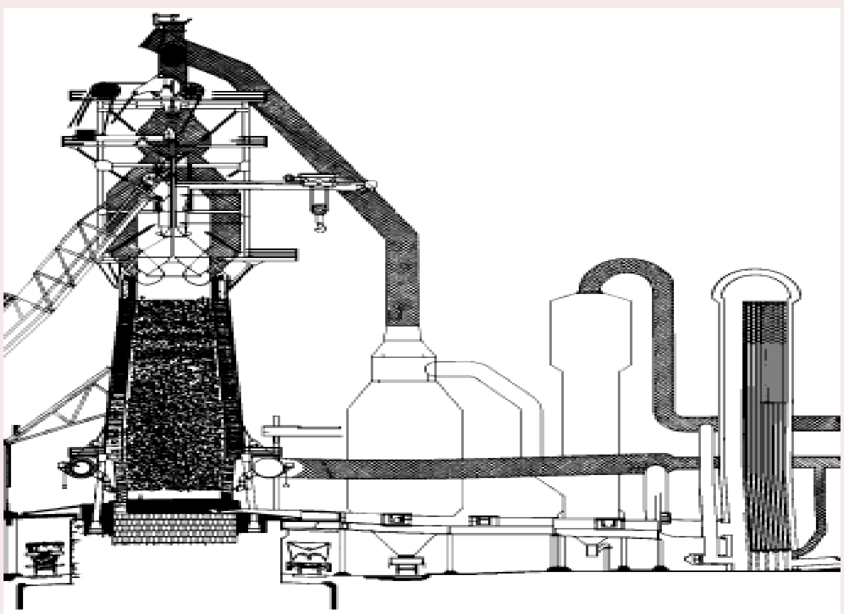
Applications

Through successful development, the Advanced Control of Operations in the Blast Furnace project promises to provide models and control schemes for improving the thermal efficiency of the blast furnace stove system and increase the efficiency, productivity, and consistency of the blast furnace iron production process.

The employment of state-of-the-art process control, modeling, pattern recognition, and optimization technologies will improve the performance of blast furnace plants in the steel industry

The steel industry uses blast furnaces to annually produce about 50 million tons of iron valued at approximately $7.0 billion. The methods to improve the consistency and efficient operation of these furnaces is of unquestioned value to the steel industry. Control of the thermal state of the blast furnace operation is dependent on many factors. Consistent delivery of the blast air at the required temperature is a key variable. When the materials charged at the top of the blast furnace do not move continuously towards the hearth of the furnace, the phenomenon is called "hanging" of the burden. Hanging conditions can develop due to a variety of reasons and is generally followed by a phenomenon called "slipping" during which the charged materials fall uncontrollably toward the hearth of the furnace in a thermally unprepared state which leads to the furnace going cold. Under extreme conditions, this could lead to a frozen furnace that causes interruption of the downstream business operations and financial losses that can be as high as $1 million/day. Improving the reliability of blast furnace operations is of critical importance to the steel industry.

Blast Furnace



Idealized cross-section of a typical blast furnace.

The Employment of State-of-the-Art Process Control (continued)

This project aims to develop: 1) a model-based controller for optimal operation of the stoves; and 2) software utilizing artificial intelligence-based pattern recognition techniques for predicting cold furnace and hanging conditions in the blast furnace to enable furnace operators to operate the blast furnace in a smooth and uninterrupted manner.

Project Description

Goal: There are two primary objectives of this project: 1) to develop a blast furnace stove control model and control scheme and to implement it on a commercial blast furnace stove; 2) to develop software to predict hanging and cold furnace conditions and implement it on a commercial basis.

The following results are expected: 1) a validated process model for the operation of the stoves, optimal firing schedules, and an efficient feedback controller that will reduce stove operation cost; 2) a software predictive tool that displays the probability and severity of a developing hanging condition and the thermal condition of the furnace in the immediate future.

Progress and Milestones

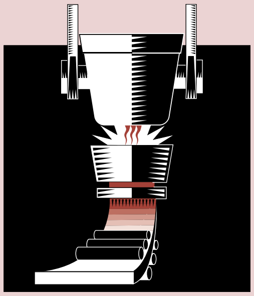
- Project start date, November 1996.
- The hot blast stove model and model based controller was installed on the Ispat Inland Inc. No. 7 blast furnace in late 1998. After initial operation on one stove, the application was extended to all three stoves serving No.7 blast furnace. The technology has reduced stove system operating costs and improved the operational consistency of the hot blast stoves. (For more information, please see fact sheet "Hot Blast Stove Process Model and Model Based Controller).
- Using historical commercial blast furnace operational data, a software package to predict future occurrence of a cold furnace and hanging condition will be developed, validated, and installed on a commercial furnace - completion delayed.
- Project completion date, November 1999 (delayed).

Commercialization Plans

- Ispat Inland Inc. has commercially applied the stove control technology and will utilize the predictive models for forecasting hanging and cold furnace conditions to improve the blast furnace performance and reliability.
- The delay in project completion has been the result of improved blast furnace operation at ISPAT Inland Inc. that has significantly reduced the incidence of cold furnace and hanging conditions, thereby causing delays in model verification and fine tuning.

Publications

- Model Based Hot Blast Stove Control and Optimization, AIChE 1997 Annual Meeting.
- Blast Furnace Stove Control, American Control Conference, June 26, 1998, Session FP-15-Steel Industry Applications.
- Hot Blast Stove Process Model and Model Based Controller, AISE 1998 Annual Meeting.
- Hot Blast Stove Process Model and Model Based Controller, Iron and Steel Engineer, June 1999.
- Optimal Operation and Control of the Blast Furnace Stoves, LANL Technical Report: LA-UR-99-5051, August 25, 1999.



Project Partners

ISPAT Inland Inc.
East Chicago, IN

Los Alamos National Laboratory
Los Alamos, NM

For additional information, please contact:

Dominic Cagliostro
Los Alamos National Laboratory
Phone: (505) 667-8500
Fax: (505) 665-3389
djc@lanl.gov
http://www.oit.doe.gov/steel

Please send any comments, questions, or suggestions to webmaster.oit@ee.doe.gov.

Visit our home page at www.oit.doe.gov

Office of Industrial Technologies
Energy Efficiency
and Renewable Energy
U.S. Department of Energy
Washington, D.C. 20585

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